

# Improving Communication Skills Through Project-Based Learning

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## 1 Introduction

In 2006, a program geared towards integrating technical communication and teamwork within engineering at the University of Utah was initiated. The program's aim was to improve communication education using technical course assignments, thereby avoiding the addition of a technical elective to an already full engineering schedule, and taking advantage of teaching communication in a direct application to the students' engineering experience. As part of this project, the Center for Engineering Leadership (CLEAR) provided graduate students from the Department of Communication and University Writing Program to instruct engineering students a few times during the semester. These sessions were used to teach specific communication concepts that could be directly applied to engineering tasks they were working on in the course (such as engineering documentation or system design papers). These writing assignments provided students with a higher level understanding of technical material as they practiced explaining it to peers and other audiences [1].

Even though this program has been very beneficial, students were still struggling with writing clear technical explanations and feeling overwhelmed by final project reports. By assessing current student lab reports, we determined that content was far more of a problem than grammar/spelling/sentence structure/format/style. In order to help students include more complete content in their reports, it was determined that a writing TA with engineering background would be essential, along with an interesting engineering project to write about. A TA with an engineering background would be able to understand the concepts students were trying to analyze and explain, and offer feedback on how to make the content more clear. The project, broken into several labs, would provide small sections that the students could write about along the way, practicing and improving as they went. These sections could later be integrated into a final report.

The project that was chosen was an FSK communication system for a cardiac pacemaker. The project was integrated across two junior-level (3<sup>rd</sup> year) engineering classes – Introduction to Electromagnetics, and Introduction to Signals and Systems, which are both taught the same semester, and which most students take concurrently. This paper describes the project and the use of writing assignments to help the students better understand the concepts and the project.

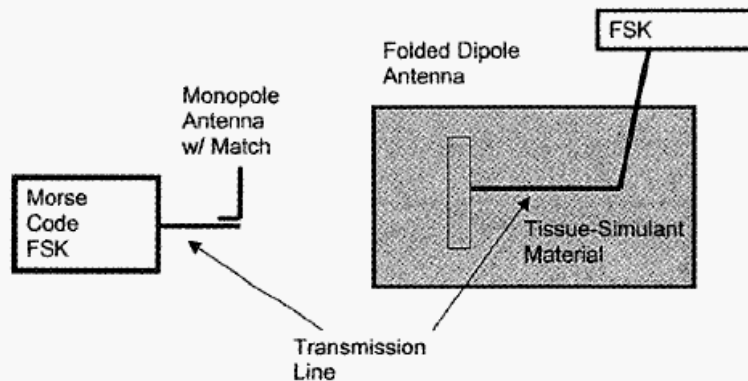
## 2 Project-Based Learning

Project-based learning engages the students in understanding basic concepts and in seeing how these concepts work together in a real-world application. Active learning maximizes learning by motivating students and emphasizing higher level thinking skills. "Writing to learn" forces students to process what they are learning in order to explain it properly [1]. In addition to increasing students' understanding of engineering concepts through application and evaluation of information, active learning has the side benefit of improving their competence in communication, which fulfills one of the goals of the Accreditation Board for Engineering and Technology's Engineering Criteria 2000 [2].

Using a project to facilitate learning fulfills many keys to learning [1]. The project brings the abstract knowledge of formulas and theories to the real world. It builds on previous knowledge to help assimilate new knowledge. It provides a contextual knowledge to help students learn concepts in relation to one another. Finally, it helps motivate the student to learn the building blocks because they know the end goal and why it will be useful. The associated lab report was formatted to help students “engage in higher order thinking skills, allowing them to move beyond mere knowledge and comprehension skills into application, analysis, synthesis, and evaluation” [3]. This allows students to be in charge of their own learning and thinking, enabling them to create documents suitable for the engineering industry [1].

## 2.1 Project

A project that integrates concepts from electromagnetics with signals and systems was chosen. An FSK communication system for a medical implant is shown in Figure 1.



**Figure 1: Block Diagram of FSK Communication System for Medical Implants [4]**

Through a series of labs for each component, the students gain a greater understanding of the concepts used to design the system as a whole. In the first lab, the dielectric properties of materials similar to those found in the human body are simulated and measured in order to evaluate propagation loss. The second lab implements Time Domain Reflectometry (TDR) and capacitance measurements to aid the students in performing a transient analysis of various types of transmission lines. In the third lab, students design a monopole antennas and impedance match it to the system. The fourth lab goes a step deeper into helping students understand transmission lines and plane waves through the use of finite-difference time domain (FDTD) analysis. In the fifth lab, students use Biot-Savart’s Law to compute the magnetic field for the monopole antenna designed in a previous lab. For the final lab, students create a link budget to evaluate how much power will be required to compensate for losses in the rest of the system, as measured from previous labs [4].

## 2.2 Learning Process

Prior to starting the technical labs, an initial lab was used as a writing lab where we gave an overview of the project, covered lab report expectations, and showed the students where to find good examples of lab reports. The lab activity consisted of two parts. The first was a class review of a sample introduction where we compared it to the required format and gave suggestions on how to improve it. The second was a practice session

where each student wrote an introduction for the final lab report, then participated in a peer review with specific instruction to verify that the introduction followed the given format. The students then used the peer review to rewrite their introduction. By writing an overview of the entire project (the introduction to the final report), the students clearly gained an early understanding of the overall lab.

Formal lab reports were expected for each lab, and a rubric was given so the students knew exactly what content was expected. The first and second lab reports were not very well written by most of the students, and even with the rubric, major important pieces of content were left out by many. The writing improved immensely after the students performed a peer review of each other's third lab report (which likely got them thinking about how to say things more clearly). Other improvements in sentence structure were made after we gave a short tutorial on how to fix the most common grammatical mistakes that students were making.

For the final lab report, some students were overwhelmed with the extensive example report template, which included formatting hints and techniques, as well as content requirements. This led us to develop a quick reference of the lab report format which included what types of topics to discuss and questions to answer in each section. This made the example more accessible to the students and reduced the number of questions they had.

### **2.3 Assessment**

Assessment was performed by giving points for content described in the rubric. Students were guided to better technical descriptions by asking them to include the following in their reports:

- Project overview
- Qualitative relation of lab project to the application of a communication device for medical implants
- Summaries of what happened in each lab
- Descriptions of lab equipment, processes, measured parameters and possible causes of errors
- Graphs and tables of results
- Observations on measurements and procedure
- Comparison of results to expected values and objectives
- Conclusions drawn
- Quantitative summary of labs
- Quantitative relation of lab results to the application

No points were taken for grammatical mistakes, but mistakes were noted on a writing feedback table shown in Table 1, and commented on in their lab reports.

**Table 1: Writing Feedback Form for Final Lab Reports**

Writing Feedback	Needs Work
Writing flow	
Spelling	
Grammar	
Past tense	
Passive voice	
Equation formatting	
Clarity of ideas	

### **3 Conclusion**

Communication skills are an essential part of engineering education in order to prepare students to be competent for engineering industry. This paper described a project-based learning activity that integrated communication through lab reports to improve students' higher level engineering skills and increase their communication skills. By guiding students to answer questions about observations and results using examples and a detailed grading rubric, we were able to see a great improvement in their technical writing. We also found that practicing the lab report format for the individual labs made the final lab report easier to compile, and the students were less overwhelmed and able to understand the big picture. Additionally, having a TA available for personal questions on grading comments helped those who needed more explanation or who had questions outside the scope of the rubric and examples.

### **References**

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